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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
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1. Altitude Laboratory

Complete general performance tests of the Liberty engine and Standard carburetor have been carried out to altitudes up to 25,000 feet. Performance with throttle control from 1/2 to full load at propeller speeds, variations of speeds from 1400 to 2,000 revolutions with fuel consumption, exhaust gas analysis, and complete heat balance measurements were included in these runs. The carburetor test plant has been used for the analysis of the metering characteristics of several carburetors and for the study of two promising automatic compensating devices, one of which gave most excellent results, appearing to be thoroughly satisfactory and reliable.

2. Lubrication Tests

Tests of several different grades of caster oil used in the Gnome engine have been completed and laboratory investigations of the difference in behavior of asphaltic and paraffine base oils have been conducted. The one cylinder Liberty engine is now in operation and is provided with means for measuring the temperatures of bearing, cylinder wall, and piston, and for observing volume-temperature relations in the piston chamber at any point of the stroke.

3. Special Power Plant Tests

Report has been prepared on a comprehensive investigation of the effect of water injection on engine power. Tests have been conducted on several so-called gasoline improvers and carbon removers at the request of the Inventions Board. A specially compounded fuel of considerable military importance has been given a series of tests in a truck engine and in the Hispano-Suiza aircraft engine. Preliminary tests of certain types of heavy fuel carburetors have been undertaken.

4. Ignition Investigations

The study of ignition problems has included the preparation of reports on the resistance of insulators at high temperatures, sparking voltage, gas leakage of spark plugs, methods of measuring heat energy of the spark, relative merits of brass and steel shells for plugs, electrical conduction

in porcelains and the general theory of the magneto. The development work on the use of an auxiliary gap in series with the spark plug has been continued. This arrangement has been made to operate satisfactorily in one type of engine when the plugs were fouled to a resistance of 4000 ohms. A device has been constructed for measuring fouling resistances on the spark plugs of an engine in operation which will be useful for the study of auxiliary gaps and of the cause and mechanism of carbon deposition.

5. Felt Testing Instrument

A patented device known as the Widney Resiliometer offered as a means of determining the resilience of felt, rubber, and other easily compressible materials, was submitted to the Bureau for inspection and test, being represented as a device in great demand for inspection work in the military services. As a result of the examination and test, fundamental errors inherent in the faulty design and construction of the instrument were found, capable of causing variations of 40 to 90 percent in its determinations,-a remarkably large error when it is considered that the special value of the instrument was supposed to consist in its ability to discriminate between samples of somewhat similar properties. The Bureau's report on this subject points out the amount and cause of the errors in detail and suggests a suitable type of instrument for the purpose, affording all requisite precision, and easily to be constructed at a cost equal to about 1/3 of the price of the instrument referred to.

6. Aeronautic Instruments

Work has been begun on the design of an altimeter corrected for the change of scale value or sensitivity of the instrument with change of temperature in addition to the usual temperature compensation at the zero, and a vibrometer for investigating airplane vibrations has been devised and is under construction, consisting essentially of a weighted diaphragm the motion of which is recorded by the use of a suitably mounted mirror directing a pencil of light to a surface of a motion picture film.

A Dutch rate-of-climb indicator of the electromagnetic type has been investigated at the request of the National Advisory Committee for Aeronautics and a report submitted. This device consists essentially of a propeller attached to the armature of a

magneto, the current developed by the magneto being proportional to the speed of the propeller and rate-of-climb. It was found that the readings obtained were inconsistent on account of the non-uniform field of the permanent magnets. Moreover, the propeller speed at 95 miles per hour was excessive. Other types of rate-of-climb indicators are being investigated.

An investigation of ground speed indicators of the inertia and gyroscopic types which involve the mechanical integration is in progress on the acceleration with respect to time and experimental models are being designed. Careful studies are being made of more important types of centrifugal tachometers and expecially at the present time with respect to the single oblique ring type. The use of a cam-plate to obtain a uniform scale is being given theoretical and experimental investigation. The matter of unsteadiness of the pointer in centrifugal tachometers is also undergoing study. An apparatus for testing the strength of aneroid diaphragms has been made, also a device for the study of the comparative durability of transmission chains of steel and gold and of metallic strips for use in the indicating train of altimeters. Plans have been laid out for conducting a course of approximately 3 weeks' duration beginning the current month on aeronautic instruments at the Bureau for the benefit of Navigation Officers, in cooperation with the Office of Operations of the Navy. During the past month aeronautic instruments circulars have been issued on the Mechanical Design of Aneroid Barometers, Tests of a Group of Danish Aeronautic Instruments; and a revision of the circular on spinning top inclinometers. Special reports have been issued also on the average results of tests to date on the Johns Manville, Jones, and Van Sicklen tachometers.

7. Electroplating Investigations

The development of improved lead coatings on gas shells of certain types is of continued importance and the Bureau is cooperating directly with the Ordnance Department and the plating contractors in an effort to secure the best possible deposits. The use of lead plating for bringing underweight shells up to standard is being extended; it is interesting to note that the new applications

of plating have the effect of occupying in work of definite value, plants which would otherwise be carrying on non-essential activities. A considerable number of trench mirrors have been submitted for test during the month, of various materials,--aluminum, steel and brass nickel-plated,--and mirrors composed entirely of nickel alloys, such as cupro-nickel and nickel-brass.

Improved methods of zinc plating are developing rapidly and numerous new applications of the method are under consideration by the military authorities, such as the nuts and bolts used on ammunition boxes, which could be made of steel and zinc plated, thus conserving considerable brass, and the Bouchon assembly for hand grenades.

8. Balloon Fabrics

More than 150 balloon fabric samples were given routine tests during the month of October. An extended report upon the characteristics of exposure tests at Washington and in cooperation with the Navy Department at Pensacola has been prepared and a report is in preparation covering the effect of impurities in balloon gases upon the fabrics, and especially upon the parts of the fabric in contact with metal fastenings. A comparison is being made of English and American methods for testing the ppermeability of fabrics. A study is being made of the application of thermal conductivity methods to the determination of permeability. The ignition of small balloons by incendiary bullets is also being given consideration.

Work has been begun upon the relation of the thread count in balloon fabrics of a given construction to the permeability,--a matter of considerable importance on account of the difficulty of obtaining a sufficient quantity of fabrics of very close weave, formerly regarded as indispensable to the obtaining of a low permeability.

9. Balloon Gas Problems

At the request of the Bureau of Aircraft Production, a study is being made of the effect of mixing oxygen with balloon gases upon their inflammability,-and of the amount of diffusion of air into a balloon required to give an explosive mixture.

10. Prepared Roofing

The development of specifications and methods of test and inspection of prepared roofing for the Construction Division of the Army is practically completed. Arrangements will be made for instruction of the inspectors in their duties, at the Bureau of Standards before they are detailed to the manufacturers' plants. There they will inspect the materials and processes and carry on tests of the roofing, sending samples of the unsaturated felt, of the saturating and surfacing bitumen, and of the mineral surfacer and finished roofing, to the Bureau for check tests.

11. Rubber Tire Testing

To meet the need for increased space and laboratory force to handle the great volume of work on solid and pneumatic tires, arrangements have been made to establish a branch laboratory at the University of Akron, at Akron, Ohio.

12. Welding Fluxes

At the request of the Shipping Board, fluxes used on American made steel rods used as electrodes in electro-welding were analyzed and found to be either sodium-silicate of sodium-silicate and asbestos.

13. Ink Powders and Ink Dyes

Recent work on the gallo-tannate of iron ink powders has shown that the addition of organic acids greatly lessens their tendency to deposit sediment when made up into writing fluids, which eliminates one of the chief objections to most powders and tablets of this type. An investigation is being made also of the dyes which are used in making writing fluids, since complaints have been received regarding the poor quality of these available.

14. Optical Instruments

In cooperation with the Inspection Division of the Ordnance Department of the Army, studies were made to the end of devising tests for the optical parts of the 37 mm gun sight telescope. A sample panoramic machine gun sight and an officers' machine gun periscope were submitted for test. A sample periscopic alidade copied from a French instrument was submitted for an examination of the optical parts and for opinion on certain deviations from the specifications desirable in order to permit the instrument to be submitted for quantity production. At the request of the Medical Supply Depot, the Bureau de-

vised a suitable set of condenser lenses to be used with an acetylene flame for the microscopic work of the Field Medical Service. Nine inspectors of the Signal Corps were detailed to the Bureau of Standards for a course of three weeks' instruction in connection with the design and testing of binoculars. These men will carry on the factory inspection of binoculars, using the Bureau's methods. Routine tests of 113 field glasses were carried on for the Signal Corps during the month of October.

15. Dark Signalling

A new combination of apparatus for dark signalling with ultra-violet light has been assembled during the past month. The device is very sensitive and has the additional advantages of eliminating the sectored disc hitherto used and of being free from the likelihood of accidental injury to the receiver.

16. Optical Glass Production

During the month of October 3020 pounds of inspected optical glass were shipped, representing 5 melts of light barium crown, 7 of barium flint, and 9 of medium flint.

17. Annealing of Optical Glass

Special reports were prepared on the annealing of borosilicate glasses for a manufacturer of optical instruments and on the annealing of optical glasses for the Navy Department.

18. Porcelain Investigations

The work respecting the development of chemical porcelain of high grade has reached a point where commercial production can be expected in the very near future. The porcelain investigations with respect to spark plugs have included a study of the rate of cooling of spark plug porcelains from the vitrification temperature as related to the type of structure developed.

19. Miscellaneous Heat Tests

Among the military tests completed in the division of heat and thermometry were the following: the explosion temperature of a four inch shell; heat leakage and mechanical shock tests of six food containers; the thermal conductivities of leather and rubber soles; eight rare metal and three base metal thermocouples for high

temperature measurements; the melting points of eight refractory sands; one sample of chrome steel; five samples of fire clay; one sample of insulating brick; special strain test of lantern globes; twenty-one airplane thermometers and a large number of thermometers of various types.

20. Hyper-Sensitizing of Photographic Plates

Work in this field of research has been continued and incooperation with the Bureau of Aircraft Production, dyes have been made available which cover types required to sensitize throughout nearly all the visible spectrum, including several samples of the most excellent properties. It has been found possible to improve the speed of other red-sensitive emulsions by means of the ammonia process, the advantage usually being two- or three-fold and sometimes considerably more.

21. Sound Ranging

During the year systematic development work has been done at the request of the War Department in developing improved apparatus for sound ranging, or location of artillery batteries by sound waves.

Early in February a complete set of apparatus developed at the Bureau was sent to France accompanied by two representatives of the Bureau, but development work was continued in an effort further to improve the apparatus. During the course of the summer very important improvements were made in a number of particulars, and an apparatus was ultimately evolved which appeared to meet all requirements of the officers of the War Department who have this work in charge.

A set of this improved apparatus was sent to France in October, 1918, accompanied by two other men from the Bureau of Standards who will use the apparatus on the American front in France. This apparatus has now reached a very high degree of development and it is planned to hold further development work in abeyance until reports as to the actual performance of the improved set in France are received. In the meantime, work is being pushed on an additional set of improved apparatus which will be sent to Italy in conformity with arrangements with the Italian Military Mission to America.

22. Centrifugal Gun

The Bureau has cooperated with the National Research Council in tests of a centrifugal gun.

The determinations made included measurements of the velocity of the projectile and of the amount of power consumed.

23. Closed-Coil Radio Transmission. The development of the use of closed coils as substitutes for radio antennae was continued. Experimental work was devoted particularly to the use of the coil as a receiver and it was found possible to determine not only the line of direction in which a radio signal comes, but in addition the absolute direction, by taking advantage of the capacity of the coil to earth, connecting a variable inductance coil between the earth and the closed coil receiver thus forming an oscillatory circuit which could be tuned to the incoming signals in the same way as the usual receiving circuit is tuned.

24. Electrical Insulating Materials for Radio Use. The study of insulating materials at radio frequency has been continued and valuable data were obtained on power loss in materials and the effects of high voltages.

25. Crystal Detectors. The investigation of crystal detectors, which was undertaken for the purpose of securing, if possible, a very sensitive detector with a permanent contact, so as to be capable of maintaining its sensitiveness under field conditions, has been brought to a close. A number of methods were investigated including alternating current electrolysis, cathode sputtering, welding, and soldering. While it was not found possible to obtain an absolutely fixed contact, fairly sensitive detectors were developed having a contact mechanically maintained. A report on this work was submitted to the Signal Corps.

26. Vacuum Tubes. A number of investigations of properties of vacuum tubes have recently been carried on including determination of the characteristic curves, capacities between elements of the tubes, etc. Sample tubes made by the various manufacturers are being given exhaustive study to determine their characteristics and possible usefulness in the design of new and improved tubes. The study of amplifiers has been given special attention.

27. Radio Manual. The manuscript of the new Radio Manual, a textbook of instruction for radio electricians, has been

completed and transmitted to the Signal Corps. The textbook includes the necessary elementary instruction in the principles of electric circuits, direct and alternating currents, dynamo-electric machinery, the theory of radio circuits, electric waves, antennae, radio apparatus, vacuum tubes, and ground telegraphy. .It is to be used in connection with the program of training radio electricians in field signal battalions as well as in special schools throughout the country.

28. Synchronization of Machine Guns and Propellers

Two distinct problems in this field have been under investigation; one involving some improvements in a system of control already in use has been completed and reported on; the second, if successful, will offer important advantages over any system now available.

29. Naval Firing Circuits

The equipment used in studying the behavior of heavy guns is being further developed and improved in connection with trials to be carried on on a battleship nearing completion, including the construction of special drums for use with high speed oscillograph films, the development of pressure meters for determining blast, and new recoil-meters. Special attention has been given to the behavior of primers which have been found to introduce some irregularities in the discharge.

30. Magnetic Compasses

At the request of the Ordnance Department, a test was made to determine the suitability of Stellite as a material for pivots of lensatic compasses. The Stellite pivot submitted proved to be superior to the usual iridium pivots. The working out of standard tests for magnetic compasses is being given careful study.

31. Magnetic Analysis

The work on the correlation of the mechanical and magnetic properties of steel is being applied to the testing of steel for rifle barrels, and preliminary studies have been made in connection with the testing of airplane tie rods. The design of equipment for the magnetic testing of small tools has been completed, and experiments have been begun with relation to the use of the magnetic method for detecting faulty welds in welded ship plates.

32. Electric Trucks and Tractors

In cooperation with the Construction Division of the War Department, extensive tests of electric trucks and tractors were carried out, including light-load and heavy load runs on each of two courses (grades 0.8% and 6.5% respectively) on 13 tractors and 13 trucks. The tests on the trucks themselves are being supplemented by further tests on the storage batteries used in them.

33. Electric Dry Cells

The work of testing dry cells is increasing. In one investigation, discharge tests were made on three different sizes of cells, the cell being discharged for short periods twice per second through a special signal lamp. The results of this investigation indicated a great advantage for the larger sizes of cells for this special service, the amount of service per unit weight for the larger cells being more than twice that for the smaller size. The smaller cells, in general, appear to be practically useless for this service. A circular on dry cells including specifications for such cells has been completed and submitted to the Standardization Committee of the War Department and is now practically ready for publication.

34. Storage Batteries

Extensive tests of storage batteries are being undertaken with especial reference to the larger types used in industrial trucks. Full advantage will be taken of the information available from other sources, such as the electrical engineering departments of the railroads and the Bureau of Steam Engineering of the Navy. Considerable attention is being given to the question of specifications and tests of storage battery electrolytes, concerning which reliable information is very scarce.

35. Airplane Landing Signals

At the request of the Air Mail Service of the Post Office Department experiments have been undertaken to devise means of directing an airplane to its landing place in bad weather, fog, or darkness, and a set of apparatus for the purpose was constructed and put into operation.

36. Reversing Stresses in Concrete

An investigation of this matter with especial relation to the stresses induced in ships at sea is now proceeding. The beam in one unit of the fatigue testing machine has failed after 1,465,000 reversals of stress by tension failure of the steel

in the upper part of the beam and compression failure of the concrete, the load being applied from below upward. The cracks which appeared permitted the entry of small particles of concrete which introduced a wedging action preventing the regaining of the neutral position of the beam to the extent of a permanent deformation of 0.331 inches. The beam in the second unit failed after 117,340 reversals, possibly due to the low percent of steel and the high tensile stresses. This beam was reinforced with 3 - 3/8" plain bars or 1%, whereas the beam in the first unit was reinforced with 3 - 5/8" plain bars, or 2½%. The matter is now undergoing further investigation.

37. Wrapping Twine

The wrapping twine used by the Post Office Department has been made of jute, the supply of which is limited and high in price. The Textile Section of the Bureau has tested various paper twines being considered for this use and has recommended that a waterproofed paper twine of certain specification be used. The routine work of this section has included the testing of a great variety of materials such as sand bags, thread, uniform cloth, carriage felt, tire duck, goldbeaters skin, parachute silk, and artificial leather.

Respectfully,

S. W. STRATTON

Director